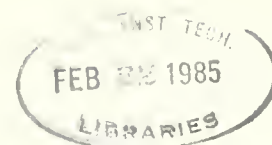Dewey

WORKING PAPER
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ON EULER-EQUATION RESTRICTIONS ON
THE TEMPORAL BEHAVIOR OF ASSET RETURNS*

Terry A. Marsh
Sloan School of Management
Massachusetts Institute of Technology

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MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
50 MEMORIAL DRIVE
CAMBRIDGE. MASSACHUSETTS 02139

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50 Memorial Drive
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1. Introduction

Much of the current thinking in finance concerning the pricing of risky assets has its origin in Markowitz's [1952] analysis of the techniques for constructing mean-variance efficient portfolios of those assets. Sharpe [1964], Lintner [1965], and Mossin [1966] all realized that a market-clearing equilibrium in which investors hold mean-variance efficient portfolios, as they will do if asset returns are normally distributed and/or if their utility functions are quadratic (Tobin [   ]), implies a model for pricing the risk of any individual asset.

Merton [1971] showed that as long as investors can trade frequently, and in the limit continuously, the Sharpe-Lintner-Mossin model holds for any concave utility function if asset returns are lognormally distributed. If the distribution of asset returns is not lognormal, but shifts around over time, Merton [1973] extended his analysis to show that the risk of any individual asset can still be priced, for any concave utility function, in terms of a set of mutual funds whose composition does not depend on investor preferences. Ross [1976, 1977] proved that if asset returns are assumed to be generated by a linear factor model, then the risk premium for any asset will be related to its factor risk and non-asset-specific factor risk premiums.

The developments from Merton (1971) onward have freed asset pricing models from their dependence on a specific form of investor utility functions. Instead, risk premiums have been expressed in terms of potentially observable prices of portfolios of assets, i.e., in reduced form. Indeed, Roll [1977] emphasized that the testable content of asset pricing models and the identity of these portfolios are one and the same.

Breeden [1979] extended the reduced form models for asset prices by showing that since an investor's optimal consumption choice will reflect his or her wealth and investment opportunities, a non-speculative price variable such as consumption could also potentially be introduced to explain the equilibrium behavior of speculative prices. That approach has been pursued further in recent empirical analyses which have focused directly on Euler equation restrictions on comovements of asset prices and variables like aggregate consumption (e.g., Mankiw [1981], Hansen and Singleton [1982,1983], Grossman and Shiller [1983], Brown and Gibbons [1983], Mehra and Prescott [1983], and Litzenberger and Ronn [1984]). Unlike Breeden's model or its reduced form predecessors, however, the Euler equation restrictions utilize explicit formulations of investors' direct utility functions. The restrictions can be obtained without completely solving investors' dynamic optimization problems, and this is often cited as the primary motivation for studying them. Of course, exactly the same is true of the asset pricing restrictions implied by Breeden's and earlier models.

Data on consumption and asset returns are typically found to "fail" the Euler equation conditions. This failure can be, and has been, interpreted in at least two ways. One is that asset prices don't even satisfy the bare bones minimum condition for rational investor behavior. In the following section, I argue that such a sweeping conclusion simply can't be logically sustained. The Euler equation condition, a necessary condition for rationality, must be supplemented by a good deal of specification which can only be sufficient, not necessary, to describe observed asset price behavior. If arbitrage opportunities are ruled out, I argue that there is always a specification of the Euler equation restrictions which is sufficient to explain asset returns.

Further, still precluding arbitrage opportunities, if asset return distributions exhibit the linearity properties usually assumed of them (and which can be rigorously justified in continuous time), then it is argued here that there are less cross-sectional degrees of freedom than typically employed in the Euler equation tests.

An alternative interpretation for the failure of the Euler equation restrictions is that "the intertemporal capital asset pricing model has...been rejected for stock prices in formal tests" (Shiller [1984, p. 46, and fn. 55]). In Section 2.2, it is argued that the Euler equation tests do not capture the essence of the CAPM, and ipso facto do not provide a sound basis for rejecting it.

While it might seem, in theory at least, that the Euler equation restrictions represent "general equilibrium" constraints on asset prices, they do so only under what might be described as "incredible conditions", to borrow Sims's [1980] terminology in a closely related context. For example, as Grossman and Shiller [1982] pointed out, the Euler equation restictions on comovements in asset prices and aggregate consumption changes require that all consumers be at an interior optimum in the solution of their intertemporal consumption-investment problems. Yet, as discussed more fully in Section 3, the vast majority of individuals whose consumption decisions are supposed to reflect the marginal utility changes at work in pricing stocks and bonds never hold or trade them, and it is implausible that this is by unconstrained choice.

Both the traditional asset pricing models and the Euler equation models make assumptions about aggregation, return distributions, and perfection of markets. However, by design, there is little robustness of the Euler equation models to the assumption that there is a representative individual whose

preferences can be standardized; that the utility function is time separable or nonseparable in some reasonably narrowly defined way; and especially that the "non-investor" qua consumer is at an interior optimum with respect to portfolio decisions. By contrast, the reduced form approach of the traditional asset pricing model puts virtually no emphasis on the perfectness of nonfinancial markets. Since financial markets tend to be large and centralized, with continuously quoted prices, relatively few restrictions on short-selling, and free entry, it seems clear that models in which preferences relevant to the pricing of stocks can be expressed as a function of asset market prices need make by far the fewest apologies for perfect market assumptions.

Nor is the consumption-oriented Euler equation model a watershed case. My criticisms are likely applicable to most, if not all, "general equilibrium" models for testing stock price relations where the tests involve the use of non-speculative price variables such as corporate dividends, accounting earnings, and production income. However, while non-speculative-price variables may not help us much in understanding speculative prices, the converse is not necessarily true. Given the rational behavior of stock prices, there is considerable promise that these price data will prove useful for understanding the properties of the nonspeculative price variables. This has been shown to be true, for example, for aggregate corporate dividends and aggregate accounting earnings (Marsh and Merton [1984a, 1984b]), and for aggregate corporate investment (Fischer and Merton [1983]). I conjecture (alas, before examining the data) that, in an unrestricted reduced form, some function of lagged stock price changes will explain consumption changes, that the explanatory power of the price changes will appear to be virtually

causal,[1] and that the Euler equation restriction will add very little, if
any, explanatory power.

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2. Euler Equation Tests

2.1 Deviation of the Tests

The Euler equations relevant here are those for the optimal solution to an investor's problem of maximizing expected utility of lifetime consumption. It is well-known that the dynamic programming solution to this problem involves balancing the marginal utility of consuming another dollar of savings in any period against the expected marginal utility of instead investing that dollar and consuming the investment returns it generates in a subsequent period. Let the "current" and "future" periods, not necessarily consecutive, be $(t-1, t)$, and let the utility function over consumption in those periods be defined as $U(C_{t-1}, \tilde{C}_t)$ where $\tilde{C}_t$ is consumption at the end of period t. Define wealth at the end of period $t-1$ as W_{t-1}. Savings in period $t - 1$, $(W_{t-1} - C_{t-1})$, can be invested in a portfolio of assets $i = 1, \ldots, N$ with returns $\tilde{Z}_{it}$ equal to one plus the rate of return $\tilde{R}_{it}$ over discrete interval t. The fractional investment in asset i is denoted by w_{it-1}.

Assuming that the representative consumer's utility function is additively separable in time, the first-order necessary conditions which must be satisfied by the optimal consumption-investment plan are:

$$E_{t-1}[\tilde{U}_2(.) \Sigma w^*_{it-1} \tilde{Z}_{it}] = U_1(.) \tag{1}$$

$$E_{t-1}[\tilde{U}_2(.)(W_{t-1} - C_{t-1})\tilde{Z}_{it}] = \lambda \tag{2}$$

where $U_1 \equiv \partial U(.)/\partial C_{t-1}$, $U_2 \equiv \partial U(.)/\partial C_t$, λ is the marginal utility of wealth, and $E_{t-1}[.]$ is the expectation operator conditional upon any information known up to the end of $(t-1)$. Multiplying

through (2) by the optimal portfolio weights w^*_{it-1} and summing over i

yields:

$$\lambda = (W_{t-1} - C_{t-1})E_{t-1}[\tilde{U}_2(.)\tilde{z}^*_t] \tag{3}$$

Using (1), (2), and (3):

$$(W_{t-1}-C_{t-1})E_{t-1}[\tilde{U}_2(.)\tilde{z}_{it}] = \lambda = (W_{t-1}-C_{t-1})E_{t-1}[\tilde{U}_2(.)\tilde{z}^*_t] = (W_{t-1}-C_{t-1})U_1(.) \tag{4}$$

$$\Rightarrow \qquad E_{t-1}[\tilde{U}_2(.)\tilde{z}_{it}] = U_1(.) \qquad \text{for all assets } i=1,\ldots,N \quad . \tag{5}$$

The interpretation of (5) as a necessary condition for optimal portfolio

and consumption choice is straightforward. Savings must be allocated across

assets so that the time (t-1) expectation of their marginal-utility-weighted

future payoffs are equal, and equal to the marginal utility of time (t-1)

consumption. As Breeden (1979) pointed out, the marginal utility of period

t consumption, and thus period t's optimal consumption choice, will reflect

the set of investment opportunities available at time t, even if the direct

utility function $U(\cdot,\cdot)$ is state-independent. Given that neither the

marginal utility function nor the possibly state-dependent probability

distribution of asset returns is observable, Samuelson and Merton [1969]

defined a composition of the two as a "utility-probability" or "util-prob"

distribution.[2] In these terms, (5) requires that the util-prob expectation

of returns be equal across assets.

2.2 Empirical Content of the Euler Equations

The overidentifying restrictions that util-prob expected returns be equal

across assets have been tested by Mankiw [1981], Hansen and Singleton [1982,

1983], and Dunn and Singleton [1984]. The restrictions have also been used by

Hansen and Singleton [1982,1983] and Brown and Gibbons [1983] to estimate
relative risk aversion, and by Mehra and Prescott [1983], Grossman and Shiller
[1983], and Litzenberger and Ronn [1984] to generate "artificial economy"
asset prices and risk premiums which can be compared with actual prices and
risk premiums.

Of course, these empirical exercises all depend upon considerably more
than the first-order necessary condition (5) alone. To bridge the gap between
the restriction implied by that necessary condition and any prescription for
asset pricing behavior, specification of the util-prob distribution, by one
means or another, is required. However, the best that can be hoped for is
that a given util-prob specification which puts flesh on the Euler equation
skeleton will be sufficient to explain asset prices. If it is not, we cannot
conclude anything about the properties of asset prices--only that a particular
util-prob specification, which was not necessary anyhow, will not explain
them. Indeed, without a dogmatic prior on the util-prob specification, we
cannot even conclude anything about whether asset prices behave "as if" the
necessary conditions for rational consumption-portfolio choice are satisfied.
Thus, the Euler equation methodology is simply an unreliable methodology for
testing the important question of whether asset prices are rational.

While resolution of the stock price rationality issue is beyond reach, it
is often stated that the Euler equation cum util-prob specification is a
"general equilibrium" version of the traditional or intertemporal asset
pricing model. This is, at best, misleading. The traditional or
intertemporal CAPM, which also assume that the Euler equation is satisfied,
simply posit that the util-prob specification is reflected in equilibrium risk
premiums on particular subsets of assets. Of course, Roll [1977] has argued

that a portfolio can always be found for which the traditional CAPM holds
exactly, even ex post. However, a util-prob specification can also <u>always</u> be
found such that any "more general equilibrium model" of asset prices holds
exactly. To see this, we have only to realize that the price of a security
$P_{i,t-1}$ can be written generally in a states-of-the-world model as:

$$P_{i,t-1} = \sum_{\tau=t}^{T} \sum_{s}^{S} \pi_{t-1}[s,\tau]\tilde{X}_i[s,\tau] \qquad (6)$$

where: $X_i[s,\tau]$ is the cash flow from security i in state s at
                 time τ ;

       $\pi_{t-1}[s,\tau]$ is the price of a dollar of cash flow, as of time
                 t-1, from any security in state s at time τ.

As shown by Rubinstein [1976], Breeden and Litzenberger [1983], Merton [   ],
Cox and Ross [   ], and Garman [   ], it follows from (6) that as a dual of
the condition that no arbitrage opportunities exist:

$$P_{i,t-1} = E_{t-1}[\tilde{\pi}'_{t-1}(s,\tau)\tilde{V}_{i,t}(s,\tau)] \qquad (7)$$

where: $\tilde{\pi}'_{t-1}(s,\tau) \equiv \tilde{\pi}_{t-1}(s,\tau)/q_{t-1}(s,\tau)$

       $q_{t-1}(s,\tau)$ = investors' probability belief that state s will
                 obtain at time τ, conditional on the state-
                 of-the-world at t-1 .

$$\tilde{V}_{i,t} = \tilde{X}_i(s,t) + \tilde{P}_{it} \qquad .$$

(7) leads immediately to:

$$1 = E_{t-1}[\tilde{\pi}'_{t-1} \cdot \tilde{Z}_{i,t}] \qquad (8)$$

where $Z_{i,t}$ is one plus the rate of return on security i over time period t, as defined above.

Expression (8) "looks like" a stochastic Euler equation, but it is structurally empty, because there will always be some (possibly non-unique) $\pi'_{t-1}(s,\tau) > 0$ for which $Z_{it} \geq 0$ with strict inequality for at least one outcome.

Replacing the state prices π'_{t-1} in (8) by a specific utility function $U(\cdot,\cdot)$, as in (5), does little to boost its content. Rubinstein [1976], Breeden and Litzenberger [1978], and Grossman and Shiller [1982] have shown that if (8) holds for all investors with power utility, then π'_{t-1} will be proportional to aggregate consumption changes. Bhattacharya [1979] showed that, as the time interval becomes infinitesimal, this proportionality will hold for all concave utility functions as long as asset prices have continuous sample paths. Suppose that we <u>define</u> C^*_t/C^*_{t-1} as that measure of consumption for which (5) holds when $\tilde{U}(C^\gamma_{t-1}, C_t) = C^\gamma_{t-1}/\gamma + \beta\, \tilde{C}_t/\gamma$. That is:

$$E_{t-1}[\ (\frac{C^*_t}{C^*_{t-1}})^\gamma\, Z_{it}\ ] \equiv 1 \qquad . \qquad (9)$$

Then define $\tilde{e}_t = (\tilde{C}_t/C_{t-1})^\gamma - (\tilde{C}^*_t/C^*_{t-1})^\gamma$ where $\{C_t\}$ is the consumption series used in the tests. Substituting in (9):

$$E_{t-1}[\ \{(\frac{C_t}{C_{t-1}})^\gamma - \tilde{e}_t\}\ \tilde{Z}_{it}\ ] = 1 \qquad . \qquad (10)$$

$$\Rightarrow \qquad E_{t-1}[\ (\frac{C_t}{C_{t-1}})^\gamma\, Z_{it}\ ] = 1 + E_{t-1}[\tilde{e}_t \tilde{Z}_{it}] \qquad . \qquad (11)$$

That is, if tests show that (11) holds when e_t and Z_{it} are not
orthogonal, the Euler equation condition for rational asset pricing will be
rejected. Alternatively, the estimate of the risk aversion parameter in (9)
will differ from that obtained by assuming that the RHS of (11) is zero.

What can we conclude about risk aversion, asset pricing, or consumption
behavior? So long as util-prob models exist in which $\{e_t\}$ is
correlated with asset returns, and these models are at least as plausible as
that in which the RHS of (11) is set to zero, the answer is nothing. Thus,
from now on, it will be assumed that asset prices and consumers are rational
to see what can be concluded, if anything, about the joint behavior of asset
prices and nonspeculative price variable such as consumption. By reasoning
which now seems to me to be in sympathy with that of Sims [1980], we may be
able to make meaningful statements about the joint behavior of these
speculative price and non-speculative-price series from their reduced form
distributions. Note that such an approach, not coincidentally, has all the
hallmarks of the portfolio-based approaches which, as discussed earlier, reach
all the way back to Markowitz's work.

2.3 Reduced Form Analysis of Asset Prices and Consumption

It is interesting that in the empirical work cited above on Euler equation
cum "general equilibrium" specification of asset pricing behavior, a good deal
of the specification is already in reduced form. True, the form of the
utility function is spelled out, but it is unlikely that this functional form
"matters much." Observed changes in U.S. per capita consumption expenditures
have a standard deviation below 5% per annum, and it is unlikely that
nonlinearity in utility functions is important over this range, a conjecture

which Mehra and Prescott's [1983] simulations can be interpreted as bearing out. Bhattacharya [1979] further pointed out that nonlinearity of utility functions won't matter in this context in the limit of continuous time, so that empirical estimates of utility parameters obtained by Euler equation methods will tend to reflect the differencing interval of the data (typically monthly or quarterly). Alternatively, for a given "small" differing interval (e.g., monthly), estimates of utility parameters obtained by "different" empirical procedures (e.g., Hansen and Singleton [1982,1983] use a nonlinear generalized method-of-moments procedure) will reflect nothing other than the relative properties of the procedures.

These observations suggest that comovements between marginal utility changes and asset returns in (5) can probably be safely replaced by comovements between consumption changes and assets returns, a corollary of the observations being that the forfeited estimate of risk aversion parameter will be poor anyhow. Of course, if utility is not time separable, or if consumption services differ markedly from consumption expenditures (e.g., Dunn and Singleton [1984]), "all bets are off" on the influence of nonlinearity, but it will be argued below that this only furthers the case for abandoning the utility-based analysis.

With the Euler equation test no longer tied to a specific form of the utility function, the comovements between consumption changes and asset returns will depend on shocks to utilities and/or wealth and technology. If utility shocks, which are generally assumed away, are important, then there is virtually no alternative to using the "reduced form" analysis. A "general equilibrium" explanation of comovements in asset returns, consumption, and

other instrumental variables in terms of direct utility shocks "...of
unexplained origin in unmeasurable influence" (Hall [   ], quoted in Sims
[1980, p. 29]) is really no explanation at all.

This leaves the probablity-technological component of the util-prob
specification to breathe testable content into the Euler equation (5). But,
for example, Hansen and Singleton [1983] suppress the technological
specification in making the assumption that asset returns and aggregate
consumption changes are joint lognormal, while Hansen and Singleton [1982]
assume that conditional moments of the distribution of asset returns and
consumption changes are a stable function of an arbitrarily specified set of
instrumental variables.

How rich a variety of joint behavior of asset returns and consumption can
be explained by technological specification? That is, how much weight does
the "prob" specification likely have in empirical versions of Euler equation
restrictions on asset returns and consumption? In the following brief
discussion, I argue that, on a priori grounds, the answer is a great deal.

Consider first Lucas's [1978] exchange economy. There, capital consists
of (say) fruit trees. Output each period consists of the fruit which falls
from the trees. The output is stochastic, following a stationary Markov
process. Output is nonstorable, so nonsatiated investors consume all output
each period. However, when time (t - 1) output and consumption are (say)
high, investors would like to carry some of their "feast" into period t
where expected marginal utility of consumption is higher. Because output is
nonstorable, their collective efforts to postpone consumption fail, but those
attempts force up the prices of the assets (the fruit trees), and so force
down expected asset returns. As Lucas shows, the extent of variation in

expected asset returns occasioned by variation in output and consumption realizations over time follows completely from the curvature of the utility function and the probability distribution generating those realizations.

Now suppose that a stochastic-constant-returns-to-scale production technology is introduced. Consumption will take place instantaneously, but producer and consumer durables have a production cycle of at least one period, and the payoff on investment is uncertain. If output in any period is high because of a transitory shock, permanent income and hence consumption will be only negligibly affected. Consumption as a fraction of output will fall, investment as a fraction of income will rise, the ex-dividend price of assets per dollar of investment (or per unit of consumption goods)--Tobin's q--will remain unchanged, as will expected asset returns, which will always equal the state-conditional expected marginal product of capital. If output is instead temporarily low, the same conclusions will follow so long as capital can be transformed into consumption goods as readily as consumption goods can be transformed into capital. Although the lack of movement in expected asset returns follows solely from the technological side in this new economy, it could also be obtained by making utility linear in consumption.

Intermediate cases will be those where utility is not linear and the production technology is not constant-stochastic-returns-to-sale. The latter could arise because production itself exhibits diminishing returns to scale, or because consumption goods cannot be instantantly transformed into any desired capital goods. If investment takes time, there is a cost of foregone consumption and, in an uncertain world, possibly foregone investments which would have been preferable ex post. In this case, temporarily high output should still be accompanied by an increase in investment, but now the shadow

price of finished capital goods in terms of consumption goods would increase, thus forcing down the conditional expected return on any asset i, $E_{t-1}(Z_{it})$ (i.e., Tobin's q would exceed unity). The unconditional expectation of $E_{t-1}(Z_{it})$ would equal the steady-state marginal product of capital, but $E_{t-1}(Z_{it})$ would be stochastically "shocked" away from that long-run tendancy. As was Lucas's point in the exchange economy without risk neutrality, $E_{t-1}(Z_{it})$ need not be serially independent of $Z_{i,t-1}$.

The more general case involves serially dependent shocks in output, though it seems that many of the features of a constant-stochastic returns to scale model with serially dependent shocks could alternately be derived in a model with uncorrelated shocks in which it takes time to turn consumption goods into capital. A priori, the serially dependent shocks scenario might be most interesting. Corporate managers spend a considerable amount of time trying to estimate which current events and demands can be expected to "persist" and so generate cash flows in the future if they make investments. Current consumption changes may constitute important information to managers (as agents of the investors) about future output and corporate cash flows as well as about discount rates.

To sum up, if a util-prob specification, rather than equilibrium risk premiums on portfolios of assets, are plugged into the Euler equation (5) to explain asset returns and consumption comovements, the "prob" component of the specification will tend to predominate. But the "prob" specification is very much in the nature of a reduced-form anyhow.

From a methodological standpoint, the Euler-equation statement of asset pricing restrictions stands in stark contrast to the models based on Markowitz's initial insight that asset pricing behavior could be understood by

reduced form reference to the movements in prices of portfolios of financial assets. The major objection which can be raised against the reduced form models is a Lucas [   ]-type critique of the assumption that the reduced-form asset pricing relationships remain stable.

Yet if Euler equation restrictions on asset prices are derived from a utility-based model which demonstrably simplifies "reality," so that its efficacy can only be judged by reference to the empirical validity of the restrictions,[3] in what sense do they differ from reduced form restrictions anyhow? If a simple utility-based model of asset pricing appears to "work," it is certainly not obvious that it is any more likely to continue to "work" under a regime change--in the finance context, a change in a firm's real investment risk--than a reduced form-Markowitz-type model, since the missing specification in the former must be assumed stable just as in the reduced form. Moreover, as Sims [1980] points out in the macroeconomic context, and Grossman and Shiller [1983] in the asset pricing context, conditional expectations can always be integrated over structural changes that do not involve a systematic change in stock price responsiveness to "nonspecualtive price" variables.

2.4 How Many Over-Identifying Restrictions on Asset Returns are There?

Euler equation-based models are typically applied to time series-cross sections of portfolio and/or individual asset returns. Yet the "degrees of freedom" afforded by the dimensionality of the cross-section is deceptively high. Suppose, for a given $U(\cdot,\cdot)$, that we find a portfolio of assets with return Z_t^* for which the Euler equation (5) holds. Suppose that the return on any asset i can be written as a linear function of Z_t^*:

$$Z_{it} = a_i + b_i Z_t^* + \varepsilon_{it} \qquad , \tag{12}$$

Then we can easily show that (5) must hold for the asset i <u>so long as</u> <u>arbitrage is ruled out</u>.[4]

Investors can "roll their own" residual ε_{it} by going long in asset i, short b_i units of the efficient portfolio, and borrowing a_i risklessly. Thus, an investor would pay nothing for an asset yielding ε_{it} because he/she does not expect to gain anything in marginal utility by making the investment.[5] That is:

$$E_{t-1}\left[\frac{U_2}{U_1}\varepsilon_{it}\right] = 0 \quad \Rightarrow \quad E_{t-1}[U_2\varepsilon_{it}] = 0 \quad \text{for} \quad U_1 \neq 0 \quad . \tag{13}$$

Arbitrage will ensure that (13) holds (Ross[ ]). But, using the definition of ε_{it} in (12), (13) implies:

$$E_{t-1}[U_2(Z_{it} - a_i - b_i Z_t^*)] = 0 \tag{14}$$

$$\Rightarrow \qquad E_{t-1}[U_2(Z_{it} - Z_t^*)] = 0 \tag{15}$$

$$\Rightarrow \qquad E_{t-1}[U_2 Z_{it}] = 0 \quad \text{if} \quad E_{t-1}[U_2 Z_t^*] = 0 \tag{16}$$

To repeat, if the linear model in (12) generates asset returns, then absence of arbitrage will ensure that the Euler equation holds for any asset so long as it holds for the portfolio Z_t^*. This point seems particularly pertinent in view of Newey's [1982] work showing that the generalized method-of-moments procedure which Hansen and Singleton [1982,1983] employ to test the orthogonality condition (5)[6]--for any set of assets, and any set of instruments in the conditioning set of $E_{t-1}[.]$, can be interpreted as a Hausman [1978] specification test using the conditioning instruments. Newey shows that different combinations of instruments give rise to different

results of the orthogonality tests, even if the model is correctly specified. The greater the information which the results of orthogonality tests of (5) for some subset of assets conveys about the likely outcome of those tests applied to other subsets of assets (for the same set of instruments), the more severe the problem of sensitivity of results to different combinations of instruments is likely to be.

2.5 Where's the Capital Asset Pricing Model?

Tests of the Euler equation restriction (5) across forecastable movements in consumption and asset returns, of which Hansen and Singleton [1983] is perhaps the best known, are often interpreted as tests of the intertemporal capital asset pricing model (for e.g., Shiller [1984, p. 46 and fn. 55]). However, this interpretation is not generally correct. To see why, we need only expand the conditional expectation in (5) to obtain:

$$E_{t-1}[\Delta \tilde{U}(.)] \cdot E_{t-1}[\tilde{Z}_{it}] + \text{Cov}_{t-1}[\Delta \tilde{U}(.) \cdot \tilde{Z}_{it}] = 1 \qquad (17)$$

where $\Delta \tilde{U} \equiv \tilde{U}_2(.)/U_1(.)$.

Hansen and Singleton's [1983] approach is to assume $\text{Cov}_{t-1}[\Delta U(.) \cdot Z_{it}]$ is a constant and test whether movements in $E_{t-1}[\Delta U(.)]$ and $E_{t-1}[Z_{it}]$ satisfy (17) when the utility function is assumed to be isoelastic. The problem is that the essence of extant asset pricing models is contained in the restriction that they impose across $E_{t-1}[Z_{it}]$ and $\text{Cov}_{t-1}[\Delta U(.) \cdot Z_{it}]$. In fact, it is very difficult to construct an equilibrium model in which $E_{t-1}[Z_{it}]$ and $E_{t-1}[\Delta U(.)]$ move together while $\text{Cov}_{t-1}[\Delta U(.) \cdot Z_{it}]$ remains constant.

Asset pricing model tests can be obtained from (17), which must hold across all assets $i = 1,\ldots,N$. Assuming, for simplicity, the existence of a riskless asset with rate of return R_{Ft}, so that $E_{t-1}[\Delta\tilde{U}] = 1 + R_{Ft}$, (18) implies the following restriction on asset risk premiums:

$$\frac{E_{t-1}[R_{it}] - R_{Ft}}{E_{t-1}[R_{jt}] - R_{Ft}} = \frac{Cov_{t-1}[\Delta U, R_{it}]}{Cov_{t-1}[\Delta U, R_{jt}]} \qquad . \tag{18}$$

Breeden and Litzenberger [1978] show that, in equilibrium, ΔU will be monotonic in aggregate per capita consumption changes, and Bhattacharya [1979] points out that this will be true, in the limit of continuous time, whatever the form of the utility function for consumption.

When the intertemporal asset pricing model is stated as in (18), Marsh [1983] shows that the restriction in (18) cannot be rejected using default-free bond return data when it is applied to real returns and allowance is made for errors in observing the consumption variable.

Because (18) holds in continuous time when $\Delta U(\ )$ is simply replaced by consumption changes, it follows that a researcher who attempts to substitute (say) an isoelastic specification in (5) or (18) will find that the resulting estimate of the relative risk aversion parameter γ may well have more to do with the length of the differencing interval than with a sharply identified "true" value of γ. Of course, if one sticks to a single asset as in (17), there will be one best estimate of γ, but that best estimate will, roughly, be only as good as the best estimate of $E_{t-1}[\Delta\tilde{U}]$, which is yet another potential explanation for the wide range of estimates of γ reported in different studies.

3. Consumption Changes as a Measure of Changes in Marginal Utility

3.1 Interior Optima

The consumption variable plays a critical role in the Euler equation tests. It takes the place of "the" wealth portfolio as an indicator of marginal utility. The general idea is that even though not all investors trade all assets, each individual knows both the opportunity set for investments and the market value of his or her wealth, and thus makes consumption decisions "as if" all assets are marked-to-market (e.g., Breeden [1979]). Grossman and Shiller [1982] point out that this means that the Euler equation should hold for any traded asset even though not all assets are traded. However, it is critical to this conclusion that the reason that individuals do not trade is a free choice and not because they are at cornerpoints in their intertemporal consumption-investment decision problems. If they were so constrained, then their consumption decisions will not reflect intertemporal consumption and investment allocations which maximize their expected utility, given the distribution of stock and bond returns observed by the econometrician.

There is substantial empirical evidence that a significant number of individuals in the U.S. are not at interior maxima insofar as their consumption decisions are concerned. It is estimated that only __% of individuals in the U.S. directly hold __% of the stocks and bonds whose pricing it is intended that (5) explain. King and Leape [1984] offer evidence that the asset holdings of even fairly wealthy individuals exhibit many apparent cornerpoints. They analyze detailed data on individual portfolio composition obtained from the Survey of Consumer Financial Decisions which is a stratified random sample of U.S. households conducted by SRI International.

They find that, although the mean (nonhuman) net worth of the households in their sample is approximately a quarter of a million dollars, only about half directly owned any equity securities, and only about 40 out of 6,010 held "reasonably complete" portfolios. Of course, given the recent capital inflows to the U.S. from abroad (about $U.S. 100 billion in 1983, which amounts to about 40% of total net U.S. investment; about $80 billion involved purchases of stocks and bonds, which is __% of the total market value of NYSE stocks), the wealth and consumption of some overseas investors might also be reasonably important in explaining U.S. stock and bond prices, but it is probable that, if anything, the distribution of holdings of non-U.S. investors would be more concentrated than King and Leape find for the U.S.

Within the U.S., it has been noted that many individual investors indirectly own stocks and bonds through pension funds and life insurance companies. However, it is not at all clear that ownership benefits from stocks and bonds held in defined benefit plans and fixed rate life insurance policies accrue to pensioners and policyholders. Indeed, it is more likely that they accrue to shareholders of firms. Even in the remaining cases where the claim of an indirect equity interest is more supportable, it seems reasonable to question whether changes in the market value of these holdings are fully taken into account in period-to-period consumption decisions. This is particularly the case since the composition of such holdings cannot be easily adjusted by individual beneficiaries. Further evidence of the absence of such marginal adjustments is found in Miller and Scholes [ ] where they show that the current tax system is more like a consumption tax system than an income tax system if individuals carry out appropriate financial decisions involving life insurance policies, etc. Yet many individuals do pay taxes on

unearned income. The evidence seems to indicate that older persons, most of whose wealth is typically composed of nonhuman capital, consume far less out of wealth changes than would be suggested by our current intertemporal allocation (life cycle) models. This behavior is particularly startling since these persons can always purchase life annuity policies to insure against the risk of unexpectedly "living too long," and therefore one must presume that bequest motives are important (though they seldom are in our intertemporal models).

Human capital is a commonly-cited example of an asset which is not traded, albeit an important one if estimates which place its net worth at 30-50% of total asset worth are accurate. As just noted, if individuals consume an amount commensurate with the value of their human capital when it is marked-to-market, the nontradeability would cause no problem in using consumption to examine the behavior of prices of traded assets. Of course, there is much ancedotal evidence of constraints in diversifying away the risks of human capital, or borrowing against it, e.g., Friedman [1957, pp. 16-17]. As an example, consider bank or credit card borrowing by individuals. Consumption financed by such borrowing will only result in the "correct" reflection of marginal utility if "borrowing rates" truly reflect movements in the expected returns on traded stocks and bonds. Few who observe variations in credit card and consumer loan rates treat them as moving in-step (or virtually so) with capital market rates such as those on Treasury bills (e.g., Wall Street Journal [December 10, 1984]). It is quite possible that these "sticky" capital market rates for "popular" forms of consumer credit would cause departures from randomness in consumption expenditures, such as that

observed by Hall [1978], _even_ _after_ incorporating asset returns in the Euler equation as in (5).

Consumption changes may be a very imperfect measure of the change in marginal utility from consuming an extra dollar of wealth even for individuals of substantial weath. This can be true even if the important distinction between "consumption expenditures" and "consumption services" is neglected. The current value of an investor's holdings of traded stocks and bonds can be easily marked-to-market by picking up a copy of the Wall Street Journal or consulting a real time quotation device (perhaps before choosing what to consume at lunch). However, what degree of relative confidence would such individuals likely have about the value of their assets which are not traded, or traded only in very thin markets? (Ask yourself how precisely you can estimate the value of your mutual fund stock after quickly checking the Wall Street Journal as compared to the value of your house or works of art after calling a couple of brokers). How might this affect an individual's propensity to consume out of changes in point _estimates_ of their wealth? If there were no uncertainty about those estimates, then it is well-known that they can achieve the "smoothest" path of their lifetime consumption by fully and immediately adjusting consumption to changes in wealth. But if there is estimation uncertainty in marking nontraded assets to market, is it likely that consumption will still be adjusted immediately and fully to changes in estimated wealth? The certainty equivalence principle notwithstanding, the answer is probably no, if only because posited utility functions are isoelastic and the process of trading assets is fundamental in generating information about their value.

Further, while the conclusion of the permanent income hypothesis is that full and immediate adjustment of consumption to wealth changes minimizes the lifetime variability of the level of consumption, such behavior will not, in general, minimize lifetime variability of changes in the level of consumption. Yet adjustment costs to changing consumption and non-additively-separable utility are among the many plausible reasons why variability in consumption changes might "matter" per se to an investor.[7] Moreover, while lagged adjustments in speculative prices must be ruled out to avoid creating arbitrage opportunities, lagged adjustments in nonspeculative price series such as consumption are not subject to any such restrictions. But as soon as changes in consumption themselves take on significance in the individual's intertemporal allocation problem, the Euler equation restriction (5) on asset returns becomes significantly misspecified. Despite its a priori plausibility, and its potential impact on the validity of the Euler equation tests, the only analysis of consumption and interest rate changes which discusses the possibility of smoothed consumption adjustments in a utility maximizing framework, of which we are aware, is that by Sims [1980]. As he points out, one of the challenges in understanding the role of consumption changes is to reconcile such a model with Hall's [1978] evidence that changes in consumption expenditures are quite random at the aggregate level.

In contrast to the implications of all these problems for models that relate speculative prices to consumption, models that relate speculative prices to other asset price series are less sensitive to these problems. Of course, "the" big problem for the traditional Sharpe-Lintner-Mossin asset pricing model is nonobservability of changes in aggregate wealth and opportunity sets due to nontrading in some assets, but at least there is hope

that the risk preferences and marginal utilities of those who hold and trade securities can be better extracted from the prices of traded securities than it can from time series data on aggregate consumption.

To summarize, consumption changes will only measure up to their role of reflecting marginal utility changes if all individuals are at interior optima in the solution of their intertemporal consumption-investment problems. There would appear to be compelling reasons for doubting this critical assumption. Indeed, one can almost reject, on a priori grounds alone, the basic thrust of an Euler equation-based approach which assumes a standardized utility function in order to deduce restrictions on the behavior of asset returns. For example, Clower and Johnson [1968] note:

> Apart from the usual motives of straightening out income streams over time, earning income, and providing a hedge against uncertainty (all of which are probably sensitive to yields) a person may hold assets in order to tyrannize his employees or bank manager, impress his neighbors, provide himself and his heirs with the means requisite to a life of noble contemplation, etc. In all circumstances, one is dealing with alternative forms of immediate gratification, many of which may involve appetites too keen to be blunted by variations in yield--certainly not financial yields. [p. 55]

This perspective is practically orthogonal to the Euler-equation approach. That is, its dictum is to forget asset returns for the purpose of explaining consumption, and instead focus on the standardization (or lack thereof) of the utility function as the important element. Of course, idiosyncracies in individual utility functions may disappear in the aggregate, but even in such cases, will the aggregate (average) reflect the marginal impact of wealth and opportunity set changes on asset prices?

3.2 Alignment of Series

One of the justifiable concerns about market efficiency tests which Shiller [1981] cited as a motivation for the development of his variance bounds tests of that proposition was their robustness to problems of alignment in time series data on dividends and stock price changes to which time series cross-section methods are sensitive. The Euler equation restrictions on comovements between series of consumption and stock price or interest rate changes, where those comovements can be conditioned on still other series of instrumental variables, are extremely sensitive to this alignment problem. As an empirical matter, interest rate and stock price changes are well known to be leading indicators of consumption and output changes.

If the lead-lag between asset returns and (say) consumption changes is ignored or misspecified in the Euler equation restrictions, they will appear to be invalid. For example, suppose that this period's interest rate is expected to covary with next period's aggregate consumption change (conditional on any information known at the beginning of the period), but not at all with this period's contemporaneous consumption change. If contemporaneous interest rates and consumption changes are mistakenly associated, the Euler equation restriction will fail, all the more so because the interest rate changes are not in the conditioning set.

Hansen and Singleton [1983] recognize and discuss the problem of alignment. They suggest that the Euler equation test be replaced by a test of whether differences in returns across securities in any period are orthogonal to information known at the end of the previous period. Ignoring any remaining alignment problems caused by nontrading in the securities, the new orthogonality condition will still be rejected if there are any differential

movements in asset risk premiums which are predictable--such a scenario is certainly consistent with the models derived, for example, in Merton [1973] and Merton [1980]. Indeed, one of the primary motivations given in the literature cited at the outset for examining consumption movements is to try to pick up differential changes in expected returns on assets due to wealth and opportunity set changes.

4. The Determinants of Asset Prices

In the preceding, it has been argued that general equilibrium
specifications for the behavior of asset prices which are keyed to movements
in aggregate consumption probably contain little information about those
prices. This does not mean, however, that efforts to spell out the
determinants of stock prices are not useful and important to financial
economics. Indeed, a "general equilibrium" model for asset prices is nothing
other than a methodology for "fundamental analysis" in the security analyst's
language. We know precious little about the quantitative links between
fundamentals and stock prices, and the voluminous literature on the subject
might be taken as a warning about how complex the issues are.

On the other hand, it may be premature to uncouple fundamental valuation
and stock price determination in the way recently contemplated by Shiller
[1984] and Tobin [1984]. One can only reach their conclusion that stock
prices behave "as if" speculative "noise" is superimposed on rational
fundamental valuations if the fundamentals can be properly identified.
Nonspeculative-price, economy-wide, aggregates such as observed consumption or
production income are unlikely to be sufficiently good measures of these
fundamentals to justify such strong assertions. Of course, security analysts
might make use of data on (say) changes in aggregate consumption when doing
fundamental analysis, but this may well be more for the purpose of predicting
cash flows than assessing the cost of funds. Given the public availability of
data on consumption, rational market prices will also reflect the implications
of aggregate consumption changes for cash flows.

My contention is that managers (who supply stocks to satisfy asset
demands) are able to infer most of their cost of capital estimates from stock

and bond price data. This price information consists not only of historical average rates of return and changes in the price of their stocks, but also changes in the variability of their stock price along with movements in their stock price relative to other financial--i.e., speculative price--changes in risk premia. One example of how such inferences could be drawn is the Merton [1980] model. Expected changes in marginal utility are observable from the riskless rate of interest.

There is also scattered evidence of other surrogates for fundamental factors which are at play in rational asset pricing, and which are more informative than forecastable movements in consumption. For example, Shiller [1981] reports that changes in the aggregate dividend-price ratio can be used to predict some of the subsequent movement in aggregate stock prices. Breeden [1982], Chen, Roll and Ross [1983], and Keim and Stambaugh [1984] find that spreads between junk bond yields and Treasury bill rates, as well as the level of stock prices for the smallest NYSE firms, can be used to predict risk premiums. And market timing models like Wells Fargo's rely in part upon comparisons of earnings changes and stock price changes (e.g., Forbes [October 22, 1984]).

Perhaps a useful framework to tie these empirical findings together goes roughly as follows. The changes in nonspeculative-price series such as aggregate consumption, corporate dividends, corporate earnings, and their projections into the future, tend to be "smooth" relative to speculative price series. A theoretical basis for this belief is that the time series of these variables--all of which are more or less control variables--are rationally determined by solving some optimal control problem. The time series of speculative price changes cannot be smoothed relative to information flows

without creating arbitrage opportunities. Thus, on average, a change in (say) accounting earnings is either preceded or accompanied by more than a proportionate change in stock prices. The result is that the earnings-to -price ratio E/P (or the dividend-to-price ratio D/P or consumption-to-wealth ratio C/W) changes in the opposite direction. If, on average, those price changes are partially associated with structural changes which lead to revisions in equilibrium risk premiums, and perhaps riskless interest rates, then the E/P, D/P and C/W ratios would appear to "predict" stock price changes. However, they would not really be "yield surrogates" in the way suggested by Ball [1978], since the predictive "action" arises almost exclusively from the price in the denominator of each of these expressions, and not from the numerator--a phenomenon which would be quite consistent with the evidence presented in Miller and Scholes [1980].[8]

While price changes signal structural changes, they need to be filtered to obtain the strongest signals. At the aggregate level, we want to use information in all moments of financial time series as well as information about the cross-sectional interaction among their realizations (as, for example, ex post "factor"-related moments which are priced?). While this might seem like measurement without theory, such an approach is compatible with plausible structural models. In the model specified below, it is consistent with any theory in which expected rates of change in wealth or stock prices, net of consumption-to-wealth or dividend-to-price payout respectively, have a steady-state tendency, but make serially correlated departures from the steady state. (Note that the amount of variability added by discount rate changes to stock prices will depend upon the half-life of the departures from the steady state.)

The idea of moving away from utility-based specifications for asset prices, and toward "reduced form" specifications in which the utility components of the fundamentals are reflected in functions of speculative price movements, is, of course, consistent with the thrust of the developmental work on asset pricing models which was described in the introduction. Whereas some (e.g., Tobin [1984, p. 2]) see any explanation of asset price behavior in terms of the movements in financial series themselves as a weakness--a "bootstrap" explanation of asset prices--others see it as a strength in that an explanation of market behavior does not have to depend upon a preference specification which in turn can only be revealed by market behavior.

This is particularly so for speculative prices which can be expected to impound a substantial amount of information which is probably generated by the very process of trading itself. For example, once cornerpoints occur in the decision problems of some individuals whom a utility-based model would (mistakenly) label as potential current-period investors, demands for securities will depend upon subsets of investors. It is reasonable to conjecture that trading and "re-trading" forms an integral part of the process of identifying the subsets of investors, and thus of the generation of stock prices. Likewise, at the macroeconomic level, the existence of cornerpoints and rigidities in individual decisions have the potential to substantially alter responses to monetary and fiscal policy actions.

INSERT

Summary

In this paper, I have argued that models which rely upon Euler equation cum utility model specification are severely limited in the empirical insight that they can provide into the determinants of rational asset prices and asset risk premiums as they are typically formulated in finance. Because the problems are inherent to this methodology, further refinements involving, for example, non-time-additive utility functions, finer distinctions between consumption services and consumption expenditures, or better nonlinear estimation procedures, are unlikely to improve such models' power.

While further research along these lines has only modest potential, it does not follow that all attempts to explore the interaction between speculative asset prices and fundamentals are without merit. To the contrary, models of the interaction between the real and financial sectors are of prime importance to continued progress in financial economics research.

An alternative approach which may avoid many of the problems with the Euler equation methodology discussed in this paper would be to connect the real and financial sectors through the interaction between firms and the capital markets instead of between consumers and the capital markets. As Brock [1982] shows and Lucas [1983,p.13] discusses, tests based on the Euler equations for consumer equilibrium can just as well be based on first-order conditions for firm value maximization, for each firm separately, and for each type of capital good.

The potential advantages of focusing on firms' optimal behavior in examining speculative prices include the following: publicly traded firms make stock and bond issues and repurchase stocks in active, competitive capital markets. Hence it is unlikely that managers of these firms are forced

into cornerpoints in their optimization problems because of the borrowing problems which likely prevent many individuals from attaining interior solutions to their consumption problems; there are plausible reasons to believe that the objective functions of firms can be "standardized" to a much greater degree across professionally managed firms subject to the discipline of "the market" (e.g., Boone Pickens) than across consumers;[9] the optimization problems of large, publicly traded firms are solved by skilled, professional managers assigned solely to that task--it doesn't seem reasonable to contend that the same expertise is generally brought to bear on individual consumption choice; and it seems likely that the data generated by corporate accountants, despite its well-known problems, is more reliable than that generated by individual household decisions as recorded by Government agencies and sample surveys.

Of course, it is easy to speculate on the fruits of new directions in financial research, but advances will come more slowly. In the meantime, evidence and a priori reasoning suggest that asset pricing models with reduced forms specified solely in terms of speculative price series are probably the most reliable means for estimating and testing equilibrium relations among security prices.

APPENDIX A

Tests Employing Conservation Laws

Under certainty, the continuous-time analog of the intertemporal utility maximization problem for which (1) and (2) are first-order-necessary conditions is:

$$\text{Max } J = \int_0^T e^{-\beta t} U[C(t)] dt$$

(23)

$$\text{s.t.} \quad C(t) + \hat{W} = W(t) \sum_i w_i R_i(t) \qquad \hat{W} \equiv dW/dt$$

As is well-known, the discrete-time Euler equation (5) is replaced by:

$$U'(C) \sum_i w_i R_i = -\dot{p}$$

(24)

where

$$p \equiv U'(C)$$

$$\dot{p} = \frac{d}{dt} U'(C) \qquad .$$

As shown by Weitzman [   ], Samuelson, Sato [   ][   ], there is a conservation law which must hold along any extremal {C*(t)} of (23). If the discount rate β is constant:

$$U[C*(t)] + \hat{W} U'[C*(t)] = \beta \int_t^\infty e^{-\beta s} U[C*(S)] ds \qquad .$$

That is: $\begin{array}{l} \text{Utility Measure} \\ \text{of Consumption} \end{array} + \begin{array}{l} \text{Utility Measure} \\ \text{of Investment} \end{array}$ = β x Utility Measure of Wealth

= Utility Measure of Income   .

(25)

If the discount rate ß is not constant:

$$U[C*(t)] + \hat{W}U'[C*(t)] = ß(t) \int e^{-\int_t^s \rho(t)dt} [U[C*(S)] - \hat{W}U'[C(s)] \frac{d}{dS} (\frac{1}{\rho(s)})]ds$$

(26)

(26) differs from (23) only in that tf incorporates capital gains and losses into the measure of wealth.

It is clear that an uncertainty analog of this conservation law would provide an alternative to using the Euler Equation (5) to test whether investors behave as if they optimize (23). The test is more general, insofar as the conservation law must hold irrespective of the precise form of U(.). If the max problem (23) is restated in terms of the goods consumption and goods income, then as in Weitzman's [   ] paper, the LHS of (25) will be net national product, since it will be the sum of consumption and the (consumption -good equivalent of the) output of investment goods. In this case, the test based on (25) would be of whether the NNP/Wealth ratio is constant over time (or varies with the discount rate as in (26).

FOOTNOTES

1   It seems fair to state that empirical work is often interpreted in terms
    of "the effects" or "the impact" of interest rates (under uncertainty, the
    whole constellation of equilibrium expected rates of return on assets with
    varying degrees of risk) on savings and investment (e.g., Feldstein
    [1979], Baskin [1978], Carlino [1982]).

2   The util-prob distribution denoted $Q(\underline{Z})$, where $\underline{Z}$ is the N-dimensional
    vector of asset returns, is defined as follows: Let P be the cumulative
    joint probability distribution of returns on the N assets; and $U'(Z^*)$
    the marginal utility of consuming the returns Z^* generated by the
    expected utility-maximizing portfolio. Then $Q(\underline{Z})$ is defined by its
    integral $\int_0^Z dQ(\underline{z})$ where:

    $$dQ(\underline{z}) \equiv U'(.)dP / \int_0^Z U'(.)dP \qquad .$$

    Thus, the util-prob expectation of returns on asset i is $E_Q(Z_i) =$
    $\int Z_i dQ$. If there is a riskless asset with instantaneous rate of
    return r, then $E_Q(Z_i) = E_Q(Z_j) = \exp(rt)$ is the necessary
    condition for optimal consumption-investment decisions.

3   Compare Samuelson's [1947, p. 91] statement: "Others, who do not admit
    the hollowness of utility, have in some cases embraced a formulation of
    the [utility] analysis which is meaningless in any operational, empirical
    sense ... market behavior is explained in terms of preferences, which are
    in turn defined only by behavior."

4   In continuous time, familiar examples for which (12) holds include options
    and other contingent claims.

5   Special cases include Black's [1981] "Simple Discounting Rule" and Banz
    and Miller's [1978] option valuation of cash flows.

6   The orthogonality condition implied by (5) is that:

    $$E_{t-1} \left[\frac{\tilde{U}_2}{U_1} \cdot Z_{it} - 1 \right] = 0$$

    for any set of instruments in the conditioning set of $E_{t-1}[.]$.

7   Another is the prosaic, but potentially important, possibility that
    published consumption numbers (particularly the monthly ones) have
    properties which are systematically different from their "true"
    counterparts (e.g., they are "smoothed" and improperly seasonally adjusted
    (Pierce [   ]). Yet another important possibility is that even aggregate
    consumption expenditures are not reliable measures of consumption services
    (e.g., Dunn and Singleton [1984]).

8   Miller and Scholes find that the variable $1/P_t$ does about as well as the variable D_t/P_t in explaining putative tax effects on firms' costs of capital.

9   I do <u>not</u> contend that all firms, particularly privately-held ones, always maximize corporate net worth in terms of a standardized optimization problem, but simply that the assumption that they do is better than the assumption that individuals do, insofar as our ability to standardize (aggregate) and observe the latter's behavior is concerned.

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